

What is claimed is:

1 1. A method of making a multiple gate electrode on a semiconductor device, comprising the
2 steps of:

3 coating a layer of gate electrode material over a semiconductor device that has been
4 previously coated with a thin film of gate dielectric; and

5 planarizing the layer of gate electrode material to a substantially planar surface prior to
6 patterning the gate electrode material to form a discrete multiple gate electrode on the
7 semiconductor device.

1 2. The method of claim 1, further comprising the steps of:

2 applying a photoresist mask of substantially uniform thickness on the planar top surface
3 of the planarized gate electrode material;

4 patterning the photoresist mask to cover a corresponding pattern of the discrete multiple
5 gate electrode; and

6 etching the gate electrode material that is uncovered by the photoresist mask to form the
7 discrete multiple gate electrode.

1 3. The method of Claim 1, further comprising the step of:

2 conforming the layer of gate electrode material with a step height increase corresponding
3 to an increased step height of the semiconductor device.

1 3. The method of claim 1 wherein, the semiconductor device comprises a silicon fin.

1 4. The method of claim 1 wherein, the semiconductor device comprises a fin of silicon and
2 germanium.

1 5. The method of claim 1, further comprising the steps of:

2 applying a photoresist mask of substantially uniform thickness on the planar top surface
3 of the planarized gate electrode material, the mask comprising photoresist and a mask material
4 selected from the group comprising, silicon nitride, silicon oxynitride, silicon oxide and photo
5 resist, or combinations thereof;

6 patterning the photoresist mask to cover a corresponding pattern of the multiple gate
7 electrode; and

8 etching the gate electrode material that is uncovered by the photoresist mask to form the
9 discrete multiple gate electrode.

1 6. The method of claim 1, further comprising the steps of:

2 applying a photoresist mask of substantially uniform thickness on the planar top surface
3 of the planarized gate electrode material;

4 patterning the photoresist mask to cover a corresponding pattern of the multiple gate
5 electrode; and

6 plasma etching the gate electrode material that is uncovered by the photoresist mask to
7 form the patterned multiple gate electrode.

1 7. The method as recited in claim 1, further comprising the step of: applying a mask over
2 the planarized surface, wherein the mask is of substantially uniform thickness for accurate
3 patterning thereof.

1 8. The method of claim 1 wherein, the gate dielectric comprises silicon oxide.

1 9. The method of claim 1 wherein, the gate dielectric comprises silicon oxynitride.

1 10. The method of claim 1 wherein, the gate dielectric comprises a high permittivity material.

1 11. The method of claim 1 wherein, the gate dielectric comprises a material having a
2 permittivity greater than 5.

1 12. The method of claim 1 wherein, the gate dielectric comprises a thickness in the range of 3
2 and 100 Angstroms.

1 13. The method of claim 1 wherein, the multiple gate electrode comprises polycrystalline
2 silicon.

1 14. The method of claim 1 wherein, the multiple gate electrode comprises a conductive
2 material.

1 15. The method of claim 1 wherein, the multiple gate electrode comprises a metal material.

1 16. A semiconductor device having a multiple gate electrode, comprising:

2 the semiconductor device having a projecting fin;

3 a multiple gate electrode on more than one side of the fin, the multiple gate electrode
4 having a substantially planar surface extending over the fin; and

5 a patterned mask on the planar surface of the multiple gate electrode, the patterned mask
6 having a substantially uniform thickness and a substantially planar surface.

1 17. The semiconductor device of claim 16 wherein, the multiple gate electrode is a portion of
2 a layer of gate electrode material having a planarized surface, and the planarized surface includes
3 the planar surface of the multiple gate electrode.